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EMERGENT EVOLUTION AND THE SOCIAL[1]

WHEN our thinking tends to congeal into two conflicting interpretations we naturally either devote our days to showing why the one must be true and the other false or we seek to escape from both by adopting a new position from which we can view each of the alternatives as a mixture of truth and falsehood. The theory of emergent evolution (Morgan), also called "evolutionary naturalism" (Sellars), "creative synthesis" (Spaulding), "emergent vitalism" (Broad), and "organicism" (L. J. Henderson), is an example of the latter tendency since it is an endeavor to avoid the "nothing but" attitude of naturalism *versus* supernaturalism, determinism *versus* freedom, continuity *versus* discontinuity, mechanism *versus* vitalism, the many *versus* the one. It corresponds in philosophy to the resolution of the more special conflict between preformation and epigenesis in embryology. Experimentation on the development of living and study of the phylogeny of living and extinct organisms have demonstrated that there is both genetic continuity and discontinuity, or the production of novelty in organisms; in other words, that evolution is not only a repetitive but also a creative process. With the increasing tendency to extend the concept of organization, in the sense of the French "agencement," also to the physical, chemical, psychological and social domains, there arises a strong probability that the various antitheses above mentioned may be resolved in somewhat the same manner as they have been in biology.

But this is all somewhat vague. A more specific statement, applicable to each empirical instance of novelty, has been formulated by the American and British realists, Holt, Spaulding, Sellars, Alexander, C. Lloyd Morgan, H. C. Brown, Conger, Jennings, Gordon, C. K. Ogden and G. H. Parker, who maintain that the unique qualitative character of organic wholes is due to the peculiar non-additive relations or interactions among their parts. In other words, the whole is not merely a sum, or resultant, but also an emergent novelty, or creative synthesis. This conception was long ago advanced by J. S. Mill, G. H. Lewes and Wundt, and since the various sciences are

[1] Address given at the Sixth International Congress of Philosophy, Division A, Cambridge, September 14, 1926, and published with its permission.

concerned with the investigation of wholes of different degrees of complexity, it is, perhaps, implicit in Comte's hierarchy of the sciences, to which we still adhere, and in our various chemical and biological classifications. According to Spaulding *"certain specific relations* recognized, named and *technically formulated in special sciences, organize* parts into wholes, and there are states of affairs resulting [we should now say "emerging"] that are identical with new properties, and that are different and distinct from the individual parts and their properties. Therefore the *reduction* of these new properties to those of the parts *in the sense of identification,* and the finding of a *causal determination* also in this same sense is *impossible.* The properties of the whole are, at least some of them, new, and in just this respect *are a "law unto themselves"* and *in this sense free.* This does not mean that they are lawless, but only that their specific principles of "behavior" are not identical with those of the parts."[2]

[2] This matter has been more fully considered by Broad (p. 77):

On the emergent theory we have to reconcile ourselves to much less unity in the external world and a much less intimate connection between the various sciences. At best the external world and the various sciences that deal with it will form a kind of hierarchy. We might if we liked keep the view that there is only one kind of stuff. But we should have to recognize aggregates of various orders. And there would be two fundamentally different types of law, which might be called "intra-ordinal" and "trans-ordinal" respectively. A trans-ordinal law would be one which connects the properties of aggregates of adjacent orders. A and B would be adjacent, and in ascending order, if every aggregate of order B is composed of aggregates of order A, and if it has certain properties which no aggregate of order A possesses and which can not be deduced from the A properties and the structure of the B-complex by any law of composition which has manifested itself at lower levels. An intra-ordinal law would be one which connects the properties of aggregates of the same order. A trans-ordinal law would be a statement of the irreducible fact that an aggregate composed of aggregates of the next lower order in such and such proportions and arrangements has such and such characteristic and non-deducible properties. If we consider the properties of a given aggregate of high order we could then divide them into three classes. (1) Those which are characteristic of this order, in the sense that all aggregates of the order possess them, that no aggregate of lower order does so, and that they can not be deduced from the structure of the aggregate and the properties of its constituents by any law of composition which has manifested itself in lower orders. These might be called the "ultimate characteristics" of the order. (2) Those which are characteristic of this order; but which could in theory be deduced from the structure of the aggregate, the properties of its constituents, and certain laws of composition which have manifested themselves, in lower orders. These might be called "reducible characteristics" of the order. (3) Properties which aggregates of this order share with those of lower orders. These might be called "ordinally neutral properties."

And, paraphrasing the dictum that to be determined by one's own nature is to be free, he adds *"Freedom consists, therefore, of action in accordance with those characteristics which subsist at a certain level of organization* but do not exist at other (lower) levels, yet is quite compatible with law and determination both at this higher level and at lower levels. Freedom of this kind subsists *at each level* of reality in the universe, not only in the mental but also through the physical and the merely subsistent realms." It is perhaps unnecessary to point to the essential similarity between emergence as thus understood and the *Gestalt* of the configurationists, Wertheimer, Koehler, Koffka, Drexler, etc.

There is evidently danger of conceiving the emergents in a fashion too schematic, too rigid and too static. The whole constituted by the organized and integrated parts need not be regarded as novel in its entirety. The novelty is variable and may be evident only in certain functional aspects of the whole. Since wholes have a manifest cumulative tendency to combine and recombine to form ever more complicated wholes, the ascending hierarchy of emergents has been much stressed. It is far from being universal, however. By loss or simplification of parts or suspension of some of their interactions, there is also an "Abbau," or unbuilding, productive of simpler emergents. This is clearly seen in the many recessive mutations of plants and animals and in the numerous secondary simplifications in such forms as parasites and other highly specialized organisms which are demonstrably descended from more complicated and nevertheless more primitive and generalized ancestors. There is, therefore, an evolution by atrophy as well as an evolution by increasing complication, and both processes may be going on simultaneously and at varying rates in the same organism. We must also remember that most authors artificially isolate the emergent whole and fail to emphasize the fact that its parts have important relations not only with one another but also with the environment and that these external relations may contribute effectively towards producing both the whole and its novelty. This tendency to abstraction has led Professor H. C. Brown to remark that "the whole is then physically more than the sum of the parts *we have taken account of,* although these may be legitimately abstracted as sufficient for correlation with the consequences of the integration. The ex-

traordinary sense of mystery some seem to feel about the process seems to me to arise from forgetting this interstitial filling that is as real as the selected elements and renders technically false the literal interpretation of the appealing paradox of the whole that is something more than the sum of its parts."

If all wholes of which the parts are organized, or exhibit those relations which we call integration, differentiation ("division of labor"), interactive accumulation, etc., among themselves and with the environment, are emergents, we must agree with Morgan that "it is beyond the wit of man to number the instances of emergence." Since no two events are identical, every atom, molecule, organism, personality and society is an emergent and, at least to some extent, a novelty. And these emergents are concatenated in such a way as to form vast ramifying systems, only certain ideal sections of which seem to have elicited the attention of philosophers, owing to their avowedly anthropocentric and anthropodoxic interests. These sections have been called levels. The word is not very apt since it conveys a spacial and static metaphor, whereas emergents must be regarded as intensively manifold spaciotemporal events. Naturally no two authors agree in their lists of levels. Metaphysicians and epistemologists like Alexander and Morgan are mainly interested in space-time, matter, life, mind and deity as successive emergent levels. To the biochemist, biophysicist, biologist, and physiological psychologist, however, life and mind are so amazingly complex and comprise so many heterogeneous processes that their blanket designation as two emergent levels can not seem very illuminating, and to the observer who contemplates the profuse and unabated emergence of idiots, morons, lunatics, criminals and parasites in our midst, Alexander's prospect of the emergence of deity is about as imminent as the Greek Kalends.

Our knowledge of organisms and their development will hardly permit us to accept such levels as life and mind as having been established *uno ictu*. Emergence must be more ambulatory, or at any rate less saltatory. If the naturalist is to accept both genetic continuity and novelty in evolution, the viable novelty at each emergence must be very small indeed.[3] This is attested both by the extraordinary slowness of phylogeny and the very subtle transitions in even the most rapid ontogenies. Even metamorphosis in organisms is only superficially saltatory. Novelties such as life and mind, conceived in wholesale fashion, are of such magnitude that we can regard them only as representing the final accumulative stages of very long series of minimal emergences. The insistence on levels becomes, therefore, largely a matter of descriptive emphasis and should not conceal the necessity for detailed scientific knowledge of every emergence and the peculiar constellations and interactions of the parts which immediately determine it.

One of the levels in which the situation, as it appears to me, is most open to investigation, is the social. Unfortunately the subject has been passed over by writers on levels with only a few vague remarks. Unfortunately, also, the science of comparative sociology has remained undeveloped. It has, in fact, fallen between two stools, because the sociologists have left the study of animal and plant societies to the biologists and the latter have been much less interested in these societies as such than in the structure or individual activities of their members. Apart from Forel and myself only a few investigators, like Espinas, Waxweiler, Petrucci and Deegener, have evinced a keen interest in nonhuman societies. Yet these, no less than human society, are as superorganisms obviously true emergents, in which whole organisms function as the interacting determining parts. Owing, moreover, to the loose and primitive character of the integration and the size of the components even in the densest societies, it is possible to ascertain the behavior of the parts and to experiment with them more extensively than with chemical and organismal wholes, since the parts of the latter are either microscopic or ultramicroscopic and are always so compactly integrated that analysis becomes very difficult and involves a considerable amount of statistical inference. Experiments in subdividing, compounding, castrating and grafting, and in introducing foreign elements with a view to observing their effects on animal and plant societies as emergent wholes, can be carried far beyond the limits of such experiments on the single living organism. For this reason, for the reason that there is a much greater wealth of emergents at the social level than is commonly supposed, and because the peculiarities of social emergence bear an interesting analogy to those of mind, you will pardon me if I descend to a rapid review of a number of biosociological details.

Social aggregates—if we employ the term "social" in its broadest sense—may be divided into two great groups, the heterogeneous and the homogeneous, the former comprising the associations of organisms belonging to different species, the latter of individuals of the same species and therefore of common genetic origin. In either group the simplest associa-

[3] I have used the word "viable" intentionally because monsters and other extreme unadapted mutations are also emergents.

tion obviously obtains between two interacting individuals, the combined behavior of which may be said to form an emergent pattern different from, though depending on, the functional peculiarities of the two component organisms. Among the heterogeneous associations we can distinguish the innumerable cases of predatism, parasitism, symbiosis and biocœnosis, which constitute a vast series of emergents varying from those of very low to those of very high integration. In predatism, the predator becomes structurally and behavioristically adapted to the prey and the latter to the predator, at least to the extent of modifying its habits of flight, concealment, defense or fecundity. In these cases we can hardly speak of association in the social sense, but it may be noted that if the predatory species indulges in too great an extermination of the prey, it must either adapt itself to some other form of prey or automatically cease to exist. In parasitism this danger is the greater because the association of host and parasite is so close as to be usually one of actual bodily contact. Moreover, the parasitic association which is exhibited, either temporarily or permanently by many thousands of animal and plant species, tends to ever greater definiteness through the selection of specific hosts by the parasites. This type of association is unilaterally aggressive like predatism, but tends in turn to lapse into a relation of mutualism, or symbiosis between the interacting individuals, again giving rise to innumerable emergents exhibiting such diverse behavioristic wholes as the helotism of alga and fungus in the lichens, the association of bacteria or *Micorrhiza* with the roots of higher plants, the singular associations of pollinating insects with flowers, between the yeasts or bacteria and the tissues of Homopterous and other insects, between ants and certain tropical trees and shrubs, the cultivation of fungi by beetles, ants and termites, etc. Finally there are the biocœnoses, or associations of plants and animals that live in particular edaphic situations, such as swamps, deserts, rain-forests, etc.—veritable welters of organisms of many species, all interacting with one another in complex predatory, parasitic and symbiotic relationships, but forming wholes in which the experienced field-naturalist can readily distinguish general adaptive patterns, though their adequate description may be impossible. In the tropics a single species of tree may harbor and nourish more than a hundred species of insects peculiar to itself and these may, in turn, be the prey of many predatory insects, reptiles, birds and mammals and the hosts of innumerable fungus, protozoan, vermian and insect parasites. We may truthfully say that there is not on the planet a single animal or plant that does not live as a member of some biocœnose.

True societies are possible only when the components belong to the same species, but the motives of their association may be very diverse. They may be said to belong to three main types according as nutritional, reproductive or defensive functions predominate in the emergent social behavior. Examples of the nutritional type are certain Cœlenterates, like the Siphonophores, corals, etc., the tunicates, tapeworms and the higher vascular plants. In all these cases the society, or colony, is formed asexually by repeated budding from a single individual and sexual reproduction is restricted to the dissemination of the species and the formation of the initial individual of the colony. Certain members of the colony may be specialized for the purpose of securing food, but this is shared by all the vitally interconnected individuals.

The sexual, or reproductive, type of society is more interesting. It starts with a peculiar temporary cooperation, or mating of only two individuals, the male and the female, and emerges with the growing up of the offspring in cooperative affiliation with the mother or with both parents. A more or less permanent family is thus formed, which may become very numerous either through the production of successive generations of offspring by the same mother or through the consociation of a number of genetically related mothers and their offspring. This is the type of society which we find among the insects, and I have been able to show that it has emerged at thirty independent points at least during the phylogeny of the class. Some of these colonies are very small and evanescent, or feebly integrated, but others are very stable, comprise many thousands of individuals (ants, honey-bees, social wasps and termites) and are very highly integrated, with so pronounced a social division of labor among the individuals that definite castes are produced (workers, soldiers, etc.) which are not only functionally, but may even be morphologically differentiated at an early stage of their post-embryonic development. Although the formation of the various castes is primarily connected with the functions of nutrition and defense the main activities of the colony center in reproduction, *i.e.*, in producing and rearing as many young as possible. That the social activities may present a very definite emergent pattern is most clearly seen in the nests of bees, wasps, ants and termites. These structures, though the result of the cooperative labor of most of the personnel of the colony, are nevertheless true *Gestalten*, being no more mere sums of the individual activities than is the diverse architecture of cities built by human hands. Not only does each species have its peculiar type of nest, but the nest of every colony of a species exhibits its own emergent idiosyncrasies.

The situation among the social insects may be com-

plicated in a very interesting manner by the tendency of their colonies to adopt alien insects as guests, or nest-mates. This is especially true of the ants and termites. These guests are really social parasites and are to be regarded as component members of the colonies in the same sense as dogs have for ages been effective members of human societies. But in the case of the social insects the behavior of the guests may produce veritable social diseases in the colonies that harbor them. As a result of their adoption even the structure and numerical proportions of the castes may be modified, although there is a demonstrable effort at social regulation on the part of the host, just as there is in the single organism whose tissues have been invaded by bacteria or other parasites. This tendency to consociation with strange organisms is carried even further in the union of whole colonies of bees, wasps and ants with colonies of alien species, and in these so-called "mixed colonies" one of the social components assumes a predatory or parasitic rôle, suppressing the fertile queen, or reproductive organ of the host colony, *i.e.*, indulging in what is known as "parasitic castration" among single organisms, and controlling the activities of the whole, so that a new emergent arises—a super-superorganism, or superorganism of the second degree.

The defensive colonies are represented by the schools, flocks, herds and bands of fishes, birds and mammals and consist of individuals, sometimes of only one sex or of the young, belonging to different families. While these congregations are usually based on sexual reproduction, their primary social function is nevertheless the protection of the individuals. There is often a vague differentiation of function as in the stationing of sentinels or of more vigorous or more formidable individuals in strategic positions when the herd is feeding or is otherwise exposed to danger. The bands of monkeys, anthropoids and primitive men constitute loose social aggregates of this pattern. We must, I believe, regard human societies above the level of the primitive savage horde as still higher emergents, *i.e.*, as super-superorganisms which not only have their reproductive bases in the consociation of numerous families, but have developed innumerable groups, or associations, all so inextricably interrelated that a single individual not only has multitudinous relations with the members of his own and other families, but may belong simultaneously to a number of different associations. The total emergent functional pattern is here so amazingly complicated that it altogether defies observation as a whole.[4] Whereas nearly all insect societies possess an ontogeny, since they have their inception in a single fertilized mother queen and exhibit a gradual growth, integration and differentiation as new individuals are successively added from the eggs of the queen till the colony attains a definite adult stature in a manner analogous to that of the ontogeny of the single organism by division and differentiation of its component cells, human society no longer possesses an ontogenetic stage but grows indefinitely by a kind of interstitial swarming, which resembles that of the honey-bee only when contingents of individuals are sent out as colonies, as occurred in ancient times among the Greeks and Romans and has been the practice of other European nations during more recent centuries.

Now the various emergents which I have very briefly discussed indicate that there is something fundamentally social in living things, and closer scrutiny shows that this must be a characteristic of all life, since every organism is, at least temporarily, associated with other organisms, even if only with members of the opposite sex and with its parents, and every organism is at least implicated in some biocœnose. This statement holds good even of such supposedly unsocial creatures as lions, eagles, sharks, tiger-beetles and spiders. There are, in fact, no truly solitary organisms. We may say, therefore, that the social is a correlate as well as an emergent of all life in the sense in which Morgan speaks of mind as being both a correlate and an emergent of life. And like the more complicated mental emergents, such as the instincts and conscious activities, striking social emergents make their appearance sporadically and often in unrelated groups of species, as I have shown among the insects.[5] Indeed, the correlations of the social—using the term in its most general sense—even extend down through the inorganic realm to the very atom with its organization of component electrons. And since reality is given as classes of elements, each represented by innumerable similar, active entities, endowed with an irresistible tendency to cohere and organize themselves into more and more complex emergent wholes, association may be re-

[4] Only in certain cases, such as ceremonials and rituals, is it possible to observe emergent social patterns as wholes, or *Gestalten*. A fine example of such a pattern, covering a wide area and many activities and carried out by many individuals, though unperceived by the latter, is the *kula* among the natives in the archipelagoes of Melanesian New Guinea as described by Malinowski in his "Argonauts of the Western Pacific."

[5] This matter is fully discussed in my "Social Life among the Insects," 1923, and "Les Sociétés d'Insectes. Leur Origine. Leur Evolution," 1926.

garded as the fundamental condition of emergence. We are, I believe, bound to assume that the organization *is entirely the work of the components themselves* and that it is not initiated and directed by extraspacial and extratemporal "entelechies" (Driesch), "organizatory factors" (Eldridge), "deity" or "élan vital" (Bergson). Such agencies are conceived as possessing remarkable foresight, although the whole multimillennial course of evolution with its innumerable *impasses* and *culs-de-sac,* its abject and tragic failures, would seem rather to be one vast monument to their colossal and hesitating inadequacy, blindness and stupidity. The resort to such metaphysical agencies has been shown to be worse than useless in our dealings with the inorganic world and it is difficult to see how they can be of any greater service in understanding the organic. The tender-minded may still delight in assuming their intervention in the development and maintenance of unicellular and multicellular organisms, whose integration is so exceedingly complicated and opaque that we are probably still centuries removed from any adequate understanding of their functional composition, but on the next level, that of the very loosely organized social, or superorganisms, in which the actual play of the components is open to inspection, it is not so easy to tolerate these ghostly presences.

I fail to understand why Alexander and Morgan select deity as the supervenient level next to mind, since their general scheme of emergent evolution most naturally demands the social as the next level in ascending order. Were prophecy in order we might ask what level may be expected to emerge beyond the social. Perhaps this may be the end of the series, with supervenient extinction, also to be accepted by the race with good cosmic manners if not with Morgan's "natural piety." It would seem, however, that the present very imperfect state of our society may allow for not a few successive emergents in the form of greater solidarity and higher ethics. But here we touch on a consideration which even Herbert Spencer felt to be ominous. Will this prospective, more intensive socialization be analogous to that of the highest social insects, a condition in which specialization and constraint of the single organism are so extreme that its independent viability is sacrificed to a system of communal bonds, just as happens with the individual cell in the whole organism? Within the groups of social insects, as we pass from the socially primitive to the more specialized, or in the ontogeny of the single colony as we pass from its earlier to its later stages, we actually witness a notable and increasing degeneration of the individual. Holmgren has shown that the supraœsophageal ganglion or brain in old kings and queens of termites shrinks to one third, while the sympathetic ganglia increase to three times their original size. And von Rosen finds that the eyes and optic ganglia of aged royalty among termites also undergo marked degeneration. Furthermore, the eyes, brain, thoracic structure and often also the pigmentation of the workers in the most highly socialized ants are less developed than they are in the workers of small primitive societies, which are more like the original solitary Vespoid ancestors. There may even be a complete suppression of the worker caste and a return, or dedifferentiation to what is, to all intents and purposes, a nonsocial life in certain ants, bees and wasps (*Anergates, Psithyrus, Vespa austriaca,* etc.) which behave as parasites in the colonies of other ants, bees or wasps. We also notice a concomitant degeneration in pigmentation and other structures as we pass from primitive forms like *Mastotermes, Archotermopsis* and *Hodotermes,* with their small colonies, to *Termes* with its huge colonies of highly specialized individuals. Many more examples might be cited but these will suffice to show that evolution by atrophy certainly accompanies an advance in social integration in the insects. Turning to man we notice a similar regressive development of the individual as civilization proceeds. There is a decline in the sense-organs (witness the number of people with congenital or acquired defects of vision, hearing and smell), anomalies in the epidermal structures (teeth, hair and pigmentation), the absence of any demonstrable improvement in the brain cortex and intelligence during historic time (possibly even some deterioration!), the greater activity of the visceral nervous system and endocrine glands as shown by the higher emotivity, increasing insanity, criminality and mob-psychology in our larger cities, etc. Add to all this the atrophy or subatrophy of our organs and tissues brought about by the ever-increasing specialization in our activities, and we can hardly fail to suspect that the eventual state of human society may be somewhat like that of the social insects—a society of very low intelligence combined with an intense and pugnacious solidarity of the whole. Even the intensification of nationality witnessed in existing human society has its counterpart in the hostility of every colony of social insects towards every other colony, even of the same species. A society of the type towards which we may be drifting might be quite as viable and quite as stable through long periods of time as the societies of ants and termites, provided it maintained a sufficient control of the food supply. Intersocietal hostility undoubtedly has its roots in the mutual hostility of the individuals, both of the cells or tissues of single

organisms and of the individual organisms composing superorganisms, and this "hostile symbiosis" is the foundation on which Morley Roberts has recently erected a very interesting theory of evolution. The primitive predatism and parasitism from which symbiosis has emerged is not lost by the individuals composing organisms or societies but merely abides in latency, as the most casual observation of our species demonstrates, ready to flare up under certain conditions with the most disastrous results, such as the death of the individual (cancer) and other malignant growths and variations, or the dissolution of society (revolution). It follows from such considerations that the optimistic conception of progress as an unceasing process in the human race may be illusory. Roberts suggests that our enlarged fore-brain, the "specific organ of civilization" (C. J. Herrick), with its ninety-two hundred million neurons, of which we are so proud, may really have originated as a malignant overgrowth (tumor), and he remarks that "in discussing the factors of evolution objections to our regarding the encroachments of the fore-brain upon the animal function of the human body as perpetual approximations to and recessions from a state of morbid over-growth, on the ground that to this we owe human progress, are wholly irrelevant. Progress, whatever it may be, is obviously relative and a healthy Neanderthal or Cromagnon man, who might as easily dispose of a modern athlete as any gorilla, could be held excused if he thought his bald and almost jawless successor to be in the highest degree degenerate. There can be no doubt that what we, perhaps in our blindness, call the upward progression of the human race, has always been accompanied, especially when advance seemed most rapid, by an increase in disease, and it would in no way be surprising if we learnt at last that the remarkable increase in the fore-brain was not only one of the causes of malignancy but was to be in the end one great cause of the extinction of man. If that proved to be a fact, such a result would but class man as one of the many races of animals which perished of special over-growths and a possible lack of fertility."[6]

[6] The degenerate or pathological character of civilization has been emphasized by many authors, including Ruskin and Carpenter. The following is from Schiller ("Ueber die ästhetische Erziehung des Menschen," 1795) and is quoted by Jung in his "Psychological Types," p. 91: "I do not ignore the advantages which the present generation, regarded as a whole and measured by reason, may boast over what was best in the by-gone world; but it must enter the contest as a compact phalanx and measure itself as whole against whole. What individual modern could enter the lists, man against man, and contest the prize of manhood with an individual Athenian? Whence then arises this unfavorable individual comparison in the face of every advantage from the standpoint of the race?" In the writings of Stärcke (Psychoanalysis and Psychiatry, Internat. Journ. Psycho-Anal. 2, 1921, p. 361–415), who actually dubs the disease of civilization "metaphrenia," I find the following remarks: "Civilization seems then to be a disease which is imposed on a certain portion of society in order to obtain a certain extra gain whereby all profit. . . . Civilization from the individual point of view belongs to neurotic phenomena. . . . We see the civilization of a people or a race built up in cycles according to the mechanisms of the obsessional neurosis, until it becomes no longer bearable; then there comes about a limitation of the useful effect through the return of the repressed material in disguised form, and a breaking through of forbidden things in war and revolution, according to the principles of the manic psychoses, while various 'isms' analogous to the paranoid fields are not lacking. . . . Civilization demands regression," etc.

The prospect is by no means pleasant. You will be delighted, I am sure, that I refrain from further comment.

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WILLIAM MORTON WHEELER

THE TONGA EXPEDITION OF 1926

THE primary object of the expedition was to make such progress in the investigation of the geologic and biotic history of the Tonga archipelago as might be possible during the months of June, July and August. The personnel of the expedition consisted of J. Edward Hoffmeister, of the University of Rochester (geology and corals), J. M. Ostergaard, of the University of Hawaii (mollusks) and Harold Ernest Parks, Mrs. Setchell and myself, of the University of California (botany). Hoffmeister and Ostergaard were directly under the patronage of the Bernice P. Bishop Museum, and the expedition as a whole was under the auspices of the same institution.

The delay of a week at Suva, Fiji, was utilized in making studies of the barrier reef and the geology and botany of the vicinity, in close sympathetic cooperation with Harry S. Ladd, Bishop Museum Fellow, who had been at work in Fiji for several months. From May 31 to August 23 our work lay in southern Tonga. Hoffmeister and Parks devoted most of their time to investigations on Eua, the remainder of their time being spent on Tongatabu, where the rest of the party were located during their entire stay. Particular attention was given to collecting corals, mollusks, foraminifera and nullipores, both living and fossil, since these constitute the bulk of the organisms preserved in the emergent reefs and are likely to be of the greatest importance as indicators of time and temperature relations. The distribution of land plants was also determined, both from the ecologic and floristic standpoints, as being likely to show similar and corroboratory relations.

Returning, our party spent a profitable day in the vicinity of Neiafu, the port of the island of Vavau, about three days at Apia, in western Samoa, and about three days again at Suva. In regard to the biotic data obtainable, it is pertinent to state that our observations were confined entirely to the winter (cooler and usually drier) season, and is lacking in material and data peculiar to the summer (warmer and moister) season. A very considerable amount both of data and material was accumulated, but detailed reports must await its study and coordination. Here may be briefly outlined, however, the main trends of our work.

BRIEF REPORT OF BOTANICAL WORK

(By William Albert Setchell)

The island of Tongatubu presents a very simple plan of plant distribution. In many places along the steep, high windward side (the liku) is a wind-swept forest formation bordered towards the ocean by a dense Pandanus association and with a low herbaceous or prostrate undershrub formation to the edges of the lower or higher cliffs. This liku forest varies somewhat in the outer associations but within is typically a Myristicetum (with *Myristica hypargyraea* as a strong dominant) over the higher portions of its range. The low leeward shore shows chiefly a succession of sandy beaches, bordered seaward by a dead fringing reef and landward by a beach standing several feet (usually about ten) above mean low water mark. Along this beach are herbaceous formations with typical Polynesian strand trees and shrubs. Between the liku forest formation on the windward ridge and the leeward formations, the gently sloping agricultural land is covered with plantations of coconuts, bananas, taro, sweet potatoes, yams, etc., interspersed with larger and smaller patches of secondary forest or bush. Through this area are scattered a few low conical hills and the surface is deeply indented on its northern edge with one

larger and two smaller shallow lagoon-sinks into which drain various seepages of fresh water, there being few springs and no streams on the land proper. The lagoons are bordered by typical mangrove associations. The ends of the crescentric or broad omega-shaped islands show transition formations between the continuous liku forest and the interrupted forest of the leeward shore. No outcroppings of volcanic rock were observed on Tongatabu, all rocks being calcareous (coral) formation covered by varying thicknesses of brownish soil.

The observations and materials of Hoffmeister and Parks on Eua indicate a plan of plant distribution similar to that of Tongatabu, modified by the greater height, steeper and higher liku cliffs, exposures of volcanic soils amid the limestone areas, more abrupt slope from liku to leeward, the presence of ravines, etc. The liku forest formations are similar on the two islands, but are proportionately more extensive and the associations are more complex, especially as to number and mixture of spices, on Eua. There are no lagoons on Eua and consequently no mangrove associations. The volcanic areas are bare or supporting a more or less scanty herbaceous formation. The ravines introduce elements lacking on Tongatabu and with seeming localization of distribution of certain species—a matter which needs further careful study.

The marine vegetation of the exposed shores is very different from that of the protected shores, the spumatophytes being more in evidence on the exposed shores and absent on the protected. During our stay summer annuals were absent, the temperature of the waters being below 25° C., dropping to 21°–22° C. much of the time. The Melobesieae, while abundant, were apparently not aiding much in reef formation and little seemed to be occurring in this direction. The rims of the basins of the lowest terrace or wave bench on the liku side were not observed as being formed of successive layers of nullipore as Lister[1] has indicated, nor is this "barrier" as he calls it, a sort of "nullipore mound," but both wave bench and basins seem to be due to unequal erosion of the general limestone mass forming the cliffs above it. No pavement nullipore surface was observed on any reef either of Tongatabu or of Eua. The fringing reef off Nukualofa seems dead since, although it is veneered by abundant coral growth on rim and just below the rim, there is very feeble cementation through nullipores.

The barrier reef off Suva in Fiji seems even more clearly dead (as a reef) and is being rapidly eroded on the surface by sea-urchin action, nullipore growth being very inadequate for preservation and expansion. The "reefs" at the entrance to Apia Harbor, on Upolu, seem to be in the transition stage between bank and reef, nullipore cementation being reasonably adequate, but no surface pavement of nullipore (*Porolithon onkodes*) as yet having been formed.

Of the floristics of southern Tonga, little can be said until the collections are critically studied. Most of the species attributed to Tongatabu and Eua were found and some additional are to be reported. This is particularly true of the marine flora. What seems to be a new genus of Melobesieae of striking honeycomb habit was prominent and abundant on the exposed liku shores of both Eua and Tongatabu. Both islands are the eastern limits of a number of Indo-Malayan as well as of Australio-Papuan species and genera.

BRIEF REPORT OF GEOLOGIC WORK

(By J. Edward Hoffmeister)

During our short stay in Suva, Fiji, the barrier reef in the harbor was studied and collections of corals made. A number of quarries in the vicinity of Suva were visited in collaboration with Dr. Harry S. Ladd, and material obtained which it is hoped will throw more light on the geologic age of the rocks.

The main geologic work was done on the island of Eua in the Tonga group. This important island lies about fifteen miles southeast of Tongatabu. It consists of a base of bedded volcanic tuff over which is a veneer of limestone. The island has been elevated so that at present it stands nearly one thousand feet above sea level. The volcanic base is exposed in many places on the high part of the island, which runs as a ridge in a nearly north-south direction. As elevation took place a series of well-developed terraces were formed which are most distinct on the eastern or liku side of the island.

Detailed work was done on the high ridge and the terraces to the east. The volcanic areas were mapped and also the extent of each terrace. Fossil corals are abundant on the seaward edge of the lower terraces; some were found on the higher terraces, but none on the highest. From a superficial study of the material found, the evidence points to the following possibilities:

(1) The highest part of the island is the oldest.

(2) Elevation has taken place with the formation of the terraces in comparatively recent times.

(3) The foraminiferal limestones which make up the high parts of the island and the inland edges of most of the terraces are older than the elevated coral reefs of the seaward edges.

(4) The elevated coral reefs were formed at the time of the formation of the terraces.

(5) Eua is the oldest Tongan island, and probably dates back to Tertiary times.

The present fringing reef at Nukualofa, on Tonga-

[1] *Quart. Journ. Geol. Soc.*, London, 47; 615, 1891.

tabu, was studied and comparisons made with the limestones of the interior. A brief time was spent in reconnaissance work on the island of Vavau to the north and also at Apia, western Samoa.

A detailed report of the geologic findings will appear as soon as the material has been carefully studied.

BRIEF REPORT OF MALACOLOGICAL WORK

(By J. M. Ostergaard)

During a period of about eight weeks, from July 1 to August 23, 1926, attention was given to the distribution and ecology of the marine Mollusca of the island of Tongatabu and neighboring islands and reefs, and to a comparison of these with those occurring in a fossil state in the limestone of which Tongatabu is composed.

The findings are: that many of the tropical species of the Pacific that occur in the warmer waters of Samoa and Fiji are rare or absent in the southern part of Tonga, while some such forms occur in a fossil state in the limestone of Tongatabu; and that among the recent species inhabiting the shore reefs is an abundance of such forms as occur in the same manner in Hawaii but which are scarce in the intervening warmer zone of the Pacific.

Deductions from these observations are that there was (possibly, in the Pleistocene), a southern expansion of the tropics in the Pacific similar to that of a northern expansion of the same period, so clearly evidenced by a comparison of the fossil marine Mollusca in the limestone of Oahu with those now living in Hawaiian waters.

WILLIAM ALBERT SETCHELL
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SCIENTIFIC EVENTS

THE AMERICAN SOLAR OBSERVATORY IN SOUTHWEST AFRICA

THE observatory to measure the heat of the sun established on the top of Mount Brukkaros in Southwest Africa by the National Geographic Society in cooperation with the Smithsonian Institution has been completed and the American observers are moving in.

Mr. A. Dryden, inspector of works under the government of Southwest Africa, with a corps of European and Hottentot laborers, has been at work on the observatory since Dr. Abbot, of the Smithsonian Institution, picked the site last March. The isolated position of Mount Brukkaros in the midst of a desert, the difficulties of getting men and materials up its rocky slopes, the heat and the scarcity of water have put so many obstacles in the way of the work that only the cordial cooperation of the British authorities could have made possible its completion so early.

The natural cave originally selected by Dr. Abbot for the observatory proper had to be abandoned due to the unsuitability of the mountain for tunnelling. A second site suffered the same fate after several hundred tons of loose rock had been removed. The third try proved successful. The site is located on the topmost ridge of the mountain.

To obtain water during the construction of the observatory, the engineers had to sink a well under the site of a dry waterfall. Two tanks excavated in the rocks with a capacity of 3,000 gallons each have been completed to catch the rare rainfall for the observers, but during the six months past no rain has fallen. However, the "rainy season" for Brukkaros occurs in February and March, when it is expected that a sufficient supply will be caught in the tanks to carry the observers through the long dry season. Until the rains come it will be necessary to haul water up on the backs of four small donkeys.

The postal authorities are erecting a special telephone wire connecting the observatory with the railway station at Tses. Over this wire the daily values for the sun's heat will be telephoned to Keetmanshoop and thence cabled to America. For the observers a special house some distance below the observatory inside the mountain has been constructed, while on the plain at the foot of the mountain a garage will house the truck by which supplies will come to them from civilization.

On this site and under these conditions the two American observers, Mr. William H. Hoover and Mr. Frederick Greeley, plan to spend the next three years.

GRANTS FROM THE LAURA SPELMAN ROCKEFELLER MEMORIAL

THE report of the Laura Spelman Rockefeller Memorial shows appropriations to the amount of $7,822,890 made during 1925 in the fields of the social sciences, child study, social work and public welfare.

Appropriations in the field of the social sciences included funds for research assistance, for books and periodicals and for international traveling fellowships. Appropriations were made to universities and other research agencies both in the United States and abroad. A total of $1,198,730 was voted for social science.

The research institutions aided during 1925 include Columbia University, $256,500 over a five-year period; University of Chicago, $61,500 over a three-year period; University of Denver, $37,500 over a five-year period; Economic Foundation, for the National Bureau of Economic Research, $20,000; Northwestern University, for the Institute for Research in Land Economics and Public Utilities, $10,000; Uni-

versity of North Carolina, for research in race relations, $15,000.

For institutions outside the United States, funds were appropriated to the London School of Economics and Political Science, $155,000; to the Hamburg Institute of International Affairs, $20,000; to the University of Stockholm, $75,000; to the National Institute of Industrial Psychology, $50,000, and to the Royal Anthropological Institute, $17,500.

Aid in the provision of books and periodicals for various European libraries was given through the American Library Association, $7,730, and through the Notgemeinschaft der Deutschen Wissenschaft, $16,500. The Reference Service on International Affairs of the American Library in Paris was voted $12,500.

Appropriations have been made for conferences as follows: American Institute of Cooperation, $12,000; American Historical Association, $25,000, including $15,000 for the Year Book of Historical Bibliography, and for the International Philosophical Congress, $7,500.

During the year the memorial has supported a limited number of research projects in social science through the National Research Council, $41,000; the Social Science Research Council, $30,000, and the American Council of Learned Societies, $15,000. In addition, $5,000 a year for five years was voted to the Social Science Research Council toward its general administrative expense.

The activities of the memorial in granting fellowships in the field of social sciences were somewhat enlarged during the year. At the present time it has representatives in eleven foreign countries and these have been requested to nominate fellows from their own country for study in any country where the memorial is represented. During 1925 thirty-seven fellows were appointed, the sum appropriated for the purpose being $155,000. Fellows who are citizens of the United States and Canada are appointed by the Social Science Research Council; during 1925 fifteen fellows were so appointed, $49,000 being made available for this purpose.

Other appropriations in this general field include Brown University, $27,000, toward a three-year study of cultural diffusion in the United States; Massachusetts Society for Mental Hygiene, $24,000, toward a three-year study of certain social consequences of mental disorders, and the American Law Institute, $60,000, toward an examination of criminal judicial procedure.

PROGRAM OF THE SECTION OF MEDICAL SCIENCES OF THE AMERICAN ASSOCIATION

SECTION N (Medical Sciences) will meet Tuesday, December 28. Each year this section has planned meetings to which workers in fields related to medicine may gather to discuss interrelated and border-line problems. Representatives from the fields of anthropology, medical entomology, parasitology, public health and bacteriology, the various divisions of medical science, are invited to bring to the meeting such problems, suggestions, solutions, as will be of interest to this group of allied workers. With increasing specialization, it was felt that there was a correspondingly increased need to compare notes with workers in allied fields. The attendance and the expressed interest has convinced the section committee that this policy meets a very real need.

The forthcoming meeting consists of two sessions. The meeting will begin with the address of the retiring vice-president and chairman of the section, Professor A. J. Carlson, of the University of Chicago, who will discuss "Tendencies in Research of the Bio-Medical Sciences."

The morning symposium will be a joint meeting with Section C (Chemistry) and will deal with the important problem of "Growth in Health and Disease." Dr. Oscar Riddle, of the Station for Experimental Evolution of the Carnegie Institution, will consider new phases of sex in relation to prenatal, postnatal growth and death. Professor Raymond Pearl, of the Johns Hopkins University, will discuss statistical and experimental studies of growth in health and disease. Professor W. J. V. Osterhout, of the Rockefeller Institute, will discuss the same problem from the point of view of the general physiologist. Professor W. W. Swingle, of the State University of Iowa, will present recent findings of the influence of the suprarenal cortex hormones on other ductless glands and on growth.

The afternoon session is to be devoted to the discussion of biological aspects of fundamental medical problems. Dr. C. L. Shear, head pathologist of the U. S. Bureau of Plant Industry, will give the botanical contribution to the symposium. He will discuss botanical pathology in relation to human pathology. Colonel J. F. Siler, of the U. S. Army, will represent the public health and medical worker in his discussion of the transmission of dengue fever by mosquitoes. Dr. L. O. Howard, chief of the Bureau of Entomology, U. S. Department of Agriculture, will present the problems of the entomologist so far as they relate to medicine. The anthropologists are represented by Professor R. Bennett Bean, of the University of Vir-

ginia, who will discuss human types in relation to medicine. And lastly, Professor Edgar Allen, of the University of Missouri, will review the influence of sex hormones and their relation to medical problems.

A. J. GOLDFORB,
Secretary of Section N

AWARD OF THE WILLARD GIBBS MEDAL TO PROFESSOR ABEL

PROFESSOR J. J. ABEL, of the Medical School of the Johns Hopkins University, is to receive the Willard Gibbs Gold Medal for the current year. This medal is awarded each year by the Chicago section of the American Chemical Society to some eminent chemist whose work in either pure or applied chemistry has received world-wide recognition. The medal was founded by William A. Converse, secretary of the Dearborn Chemical Company, and has been named the Willard Gibbs Medal after one of America's most distinguished physicists and chemists, Josiah Willard Gibbs.

The choice of a recipient for the Willard Gibbs Medal is made by a jury of twelve chemists from the country at large. The jurors for this year include Professor Roger Adams, director of the chemical laboratory of the University of Illinois; Professor Edward Bartow, head of the department of chemistry at the State University of Iowa; Professor W. D. Harkins, of the University of Chicago; Dr. W. Lee Lewis, formerly head of the department of chemistry at Northwestern University and at present in charge of chemical research for the American Institute of Meat Packers; Professor J. F. Norris, president of the American Chemical Society and professor at the Massachusetts Institute of Technology; Professor Julius Stieglitz, head of the department of chemistry of the University of Chicago; Dr. E. W. Washburn, formerly of the University of Illinois and now chief chemist of the Bureau of Standards, and Professor F. C. Whitmore, head of the department of chemistry at Northwestern University.

Professor Abel was born in Cleveland in 1857 and studied at the University of Michigan and in Europe. He received the degree of doctor of medicine from the University of Strasbourg in 1888. He has been the recipient of numerous honorary degrees, including one from Cambridge University in England. At present he is professor of pharmacology at Johns Hopkins University and is editor of the journal *Pharmacology and Experimental Therapeutics*.

Professor Abel's research has been largely in the field of glandular extracts. He was first to isolate the drug epinephrin from the suprarenal glands. This was the first substance secreted by the glands of the body to be isolated as a pure crystalline product. Professor Abel has obtained a concentrated substance from the pituitary glands of such potency that one part in a billion is physiologically effective, and he announced the preparation of crystalline insulin. Professor Abel follows a long list of eminent chemists as a recipient of this medal which will be awarded by the Chicago Section of the American Chemical Society at its May meeting.

SCIENTIFIC NOTES AND NEWS

ON the occasion of the fiftieth anniversary celebration at the Johns Hopkins University, a portrait of Dr. Ira E. Remsen, the first professor of chemistry of the university and its second president, was presented to the university. William M. Burton, president of the Standard Oil Company of Indiana, delivered greetings to Dr. Remsen. The portrait is by Dr. Remsen's son, Ira E. Remsen, Jr.

HONORARY degrees of doctor of science were conferred by the University of Rochester on Dr. Frederich von Müller, professor of internal medicine in the University of Munich, and Dr. Andrew Balfour, director of the London School of Hygiene and Tropical Medicine, on the occasion of the exercises dedicating the new medical school on October 25.

PRESENTATION of the Grasselli medal to Dr. Charles Raymond Downs took place on November 5 on the occasion of a joint meeting of the American Section of Society of Chemical Industry, the New York Section of the American Chemical Society, Société de Chimie Industrielle and the American Electrochemical Society. At an informal dinner in the evening at the Chemists' Club, New York, Dr. Treat B. Johnson, of Yale University, spoke on "The Medalist and Award." Dr. Downs gave an address entitled "Some Speculations in Catalytic Oxidation Reactions" and Professor Gerald Wendt, of the Pennsylvania State College, spoke on "Phenomena related to Catalysis."

C. S. JARVIS, associate highway engineer of the U. S. Bureau of Public Roads, has been awarded the J. James R. Cross gold medal by the American Society of Civil Engineers for his paper on "Floodflow Characteristics."

THE Kelvin Medal of the British Institution of Civil Engineers for 1926 has been awarded to the Honorable Sir Charles A. Parsons.

IN honor of the forty-seventh anniversary of the invention of the incandescent electric lamp by Thomas A. Edison, a special radio program was broadcasted from Schenectady for reception and rebroadcasting in Great Britain and South Africa.

THE council of the British Institute of Transport has conferred its Aviation gold medal upon Sir Alan J. Cobham in recognition of his noteworthy services to the development of empire air communications. The presentation took place at the meeting of the institute held at the Institution of Electrical Engineers on October 19.

GREENLEAF WHITTIER PICKARD has received the medal of honor of the Institute of Radio Engineers, of which he is past-fellow and president, in recognition of his contributions to the advancement of radio science.

AT a luncheon tendered to Dr. M. Kamo, head of the department of mechanical engineering at the University of Tokyo, at the Engineers Club, New York, on October 20, plans for holding an international engineering conference in Japan were discussed. A formal invitation to participate in such a conference in the fall of 1929 has been received by the five engineering societies.

THE board of trustees of the Battle Creek Sanitarium, Battle Creek, Mich., gave a banquet on October 13, in commemoration of Dr. John Harvey Kellogg's fiftieth anniversary as superintendent of the sanitarium.

THE University of Porto Rico has conferred an honorary degree upon Dr. Alexander Petrunkevitch, professor of zoology at Yale University, who was visiting professor of biology at that university last year.

PROFESSOR E. SCHMIEGELOW, of Copenhagen, celebrated his seventieth birthday on October 13, when he retired from active service as chief of the otolaryngological clinic at the hospital of the University of Copenhagen. His friends in many countries marked the occasion by presenting to the clinic a medallion portrait in bronze.

AT the fifty-fifth annual meeting of the American Public Health Association, Buffalo, on October 14, Dr. Charles V. Chapin, superintendent of health, Providence, R. I., was elected *president;* Drs. Herman N. Bundesen, Chicago; Alexander J. Douglas, Winnipeg, and Francis E. Fronczak, Buffalo, *vice-presidents,* and Dr. Louis I. Dublin, of the Metropolitan Life Insurance Company, New York, *treasurer.*

DR. GEORGE DAVID STEWART, professor of surgery at the Bellevue Hospital Medical College, New York, has been named president-elect of the American College of Surgeons for the ensuing year. The president for the present year is Dr. W. W. Chipman, of Montreal.

AT the thirty-fourth annual meeting of the Association of Military Surgeons of the United States, held at Philadelphia on October 17, Surgeon-General Merritte W. Ireland was elected *president;* Colonel Frederick H. Vinup, Maryland National Guard; Claude H. Lavinder, U. S. Public Health Service; Brigadier-General William H. Wilmer and Captain James C. Pryor, U. S. Navy, *vice-presidents,* and Colonel Jefferson R. Kean, U. S. Army, retired, *secretary-treasurer.*

AT the thirty-seventh annual meeting of the Association of American Medical Colleges, which met in Cleveland from October 25 to 26, Dr. Charles F. Martin, Montreal, was elected *president;* Dr. Guy L. Noyes, Columbia, Mo., *vice-president,* and Dr. Fred C. Zapffe, Chicago, *secretary-treasurer.* The next annual meeting will be held in Montreal on October 24 and 25, 1927.

DR. T. SATO has been made director of the bureau of epidemiologic information recently founded at Singapore by the health section of the League of Nations.

DR. CLAUS SCHILLING, professor at the Robert Koch Institute for Infectious Diseases, Berlin, has been appointed a member of the Malaria Commission of the League of Nations.

A. E. CRAVER, research chemist of the Grasselli Chemical Company at Cleveland, resigned recently to accept a position with Weiss and Downs, of New York City.

DR. A. L. WHITING has resigned his position as associate professor in agricultural bacteriology at the University of Wisconsin and is going into commercial work at Urbana, Illinois.

DR. JAMES A. TOBEY, who has recently completed a study of the public health work of the federal government for the Institute for Government Research, Washington, D. C., has been appointed scientific consultant to the Borden Sales Company of New York.

ON the recommendation of the medical graduate committee, the board of governors of the Mayo Clinic has awarded the J. William White Scholarship for the study of surgery in foreign countries to Dr. Estes H. Hargis for conspicuously meritorious work during his fellowship in the Mayo Foundation. This scholarship was made possible by a gift from the late J. William White, professor of surgery at the University of Pennsylvania, and is open to physicians who have received the degree of master of science from the University of Minnesota for work done at the Mayo Foundation. Dr. Hargis is the first recipient of the award.

DR. ALFRED E. BURTON, of Carmel, Calif., first dean of the Massachusetts Institute of Technology, has been appointed manager of plans for a quadrangle of dormitories to be built by the alumni of the institute.

DR. R. J. A. BERRY, professor of anatomy in the University of Melbourne, Australia, has accepted the invitation of the Rockefeller Foundation to visit the United States and discuss the proposed establishment of a medical research institute in connection with the erection of the new Melbourne Hospital.

DR. PETER W. HOLST, director of the department of epidemiology, State Serum Institute, Oslo, Norway, and Dr. Marius Kaiser, director of infectious disease control, Central Health Service of Austria, were recently the guests at a luncheon of the Louisiana State Board of Health.

DR. HANS C. JACOBAEUS, professor of clinical medicine at the University of Stockholm, visited the Mayo Foundation during the week of October 10, before going to Cleveland to attend the meeting of the Interstate Postgraduate Assembly.

J. P. HARRINGTON, ethnologist of the U. S. Bureau of Ethnology, has returned from his field work among the Mission Indians of California. He also assisted the chief of the bureau in the excavation of Elden Pueblo ruin near Flagstaff, Arizona.

PROFESSOR E. D. MERRILL, of the University of California, has been granted $100 from the Dr. Charles Budd Robinson fund of the New York Botanical Garden, to aid in botanical field work in Indo-China, carried on by Dr. Petelot, with the especial object of obtaining specimens of little-known species described by the botanist Louriero in 1790.

DR. MARIA PETRONELLA LOHNIS, of Delft, Holland, has come to America on a Holland American Foundation fellowship and expects to spend the present semester in work on root nodule bacteria at the laboratories of agricultural bacteriology of the University of Wisconsin.

PROFESSOR H. H. WING, head of the department of animal husbandry of the College of Agriculture, at Cornell University, has sailed from New York *en route* to Santiago, Chile, where he will attend the Chilean National Exposition.

DR. HARLEY H. BARTLETT, head of the department of botany and director of the Botanical Gardens of the University of Michigan, will spend the coming year in botanical exploration in eastern Asia. He will visit Japan, and afterwards carry on field work in Sumatra and in Formosa.

DR. GEORGE GRANT MACCURDY, of Yale University, director of the American School of Prehistoric Research, attended the organizing meeting of the International Bureau of African Languages and Cultures in London on June 28 and 29, as a delegate from the National Research Council, division of anthropology and psychology.

DR. CHARLES A. SHULL, professor of plant physiology at the University of Chicago, is spending the fall quarter in research at the University of Minnesota. He is working on electrical potentials of membranes in relation to absorption of substances through seed coats, conducting his study in the laboratory of plant physiology.

DR. W. W. COBLENTZ, chief of the radiometric section of the U. S. Bureau of Standards, has left for Flagstaff, Ariz., to join with Dr. Lampland, of the Lowell Observatory, in observations intended to determine the temperature of the planet Mars.

THE Scripps Metabolic Clinic, California, has arranged to give its third annual complimentary dinner at La Jolla to the San Diego County Medical Society. The lecture this year will be given by Dr. Elliott P. Joslin, of Boston.

DR. CHARLES B. DAVENPORT, of the Carnegie Institution of Washington, addressed the New York Physicians' Association on October 27 on "The Growth of the Child."

DR. ALEŠ HRDLIČKA, of the U. S. National Museum, gave on October 26 the last of a series of lectures on "The Origin and Evolution of Man" at St. John's College, Annapolis.

THE Minnesota section of the American Society of Plant Physiologists held its first meeting of the year on October 14. Following the business meeting, Dr. Charles A. Shull, of the University of Chicago, addressed the seminar on "Researches on Membrane Potentials in Relation to the Absorption of Substances through Plant Membranes." About fifty persons were present.

PROFESSOR JOHN W. HARSHBERGER, professor of botany in the University of Pennsylvania, will read a paper on "Alaska and its Vegetation" at a meeting of the American Philosophical Society to be held in Philadelphia on November 5.

DR. EDWIN B. HOLT, visiting professor of psychology at Princeton University, will give this winter ten lectures on "The Psychology of Response" at the New School for Social Research, New York City.

PROFESSOR F. NEUFELD, director of the Robert Koch Institute for Infectious Diseases, Berlin, gave the

Cutter lecture in preventive medicine at the Harvard Medical School on November 3, taking as his subject "Immunity in its Significance to Epidemiology." On October 15 he lectured before the scientific staff of the Rockefeller Institute for Medical Research, New York, on "The Chemotherapy of Bacterial Disease."

SENATORE G. MARCONI gave the James Forrest lecture before the British Institution of Civil Engineers on October 26 on the subject of "Radio Communication."

PROFESSOR R. A. WHIDDINGTON, professor of experimental physics at the University of Leeds, lectured at the Bureau of Standards, on October 15, on his work on the nature of luminous discharge in vacuum tubes.

DR. ROBERTO ALESSANDRI, professor of surgery at the University of Rome, gave a lecture at the Mayo Foundation on the evening of October 15.

PROFESSOR DR. C. RASCH, of the University of Copenhagen, gave an address on the effect of light on the skin and skin diseases, at the meeting of the Dermatological Section of the Royal Society of Medicine, on October 21.

THE Bradshaw lecture was delivered before the Royal College of Physicians of London on November 4, by Dr. F. G. Crookshank, his subject being "The Theory of Diagnosis." The FitzPatrick lectures, on "Medicine in Ancient Assyria," will be given by Dr. Arthur Shadwell on November 9 and 11. The subject of Dean Inge's David Lloyd Roberts lecture, to be given on November 19, is "Racial Degeneration."

To perpetuate the labors of the late Professor Edward S. Morse, formerly professor of zoology in the University of Tokio and director of the Peabody Museum, a committee has been formed to raise a fund bearing his name and establish it at the Museum of Fine Arts at Boston, where he spent thirty-three years. It is intended that the income from the fund shall be used to augment the collection of pottery, the department of which Professor Morse was a member.

PROFESSOR WILLIAM J. HUSSEY, director of the observatory at the University of Michigan, died in London on October 28, aged sixty-four years. Professor Hussey was *en route* to Bloemfontein, South Africa, to establish a university observatory station there.

DR. EMANUEL CHARLES FLEISCHNER, formerly professor of pediatrics at Stanford University, died on October 11.

DR. HAZEN GREELEY TYLER, professor of experimental engineering at New York University, died on October 27, at the age of thirty-six years.

THE death is announced of Dr. Emil Kraepelin, professor of psychiatry in the University of Munich.

DR. B. F. HOFMANN, professor of physiology at the University of Berlin, has died, aged fifty-five years.

THE *Journal of Terrestrial Magnetism* records the death of Professor Ernst Biese, for many years director of the Meteorological Observatory of Helsingfors, Finland, and of Colonel Francises S. Chaves, the director of the Meteorological Service of the Azores.

WE learn from the *British Medical Journal* that a committee has been formed in Edinburgh to celebrate the centenary of Lister's birth, and in view of the annual meeting of the British Medical Association in Edinburgh it has been decided to make the celebration coincide with it. Arrangements are being made to offer a prize of £25 and a gold medal for the best essay submitted on the subject, "The Influence of Lister on the Evolution of Surgery." This prize will be open to medical students of any medical school in the British Empire and graduates of not more than one year's standing. A book dedicated to Lister's life and writings is being prepared, and will probably contain about two hundred pages of small quarto size. A public meeting will also be held, at which addresses will be given by Sir William Watson Cheyne, Professor Tuffier (Paris), Dr. Harvey Cushing (Boston), Professor Caird (Edinburgh), and Mr. Hamilton Russell (Melbourne). A museum containing some of the more interesting relics of Lord Lister's life and work is being got together.

ACCORDING to an Associated Press dispatch, the 1926 Nobel prize in medicine will not be distributed this year. No work brought to the attention of the Swedish Academy of Medicine, which makes the awards, was of such outstanding merit as to qualify under the terms of the will left by Alfred Nobel, founder of the prizes. Last year's prize, which was also withheld for similar reasons, will now be added to the original fund, but the 1926 prize will be held for presentation next year. A previous dispatch, copied in the last issue of SCIENCE, announced the awarding of the prize to Dr. Johannes Fibiger, of Copenhagen.

THE autumn meeting of the National Academy of Sciences, which takes place in Philadelphia on Monday and Tuesday, November 8 and 9, will hold its business and scientific sessions in the lecture room of the zoological laboratory of the University of Pennsylvania. According to the preliminary program the headquarters of the meeting will be at the Bellevue-Stratford Hotel, where a subscription dinner will be served for members at 7:30 on Tuesday evening.

On Monday at 8:30 a reception will take place at the university museum for members and their friends.

THE annual meeting of the American Society of Mechanical Engineers will be held in New York during the first four days of the week beginning December 6. Monday will be taken up with the usual council meeting, committee meetings and conference of local sections' delegates, the program opening on Monday evening for the informal get-together. Tuesday morning the technical sessions start, and continue through Thursday afternoon. On Tuesday evening, William L. Abbott will deliver his presidential address, and the new president, Charles M. Schwab, will be inducted into office. The program includes the ceremony of the award of the John Fritz Medal to Dr. Elmer A. Sperry. The dinner will be held on Wednesday evening, December 8, at the Hotel Astor, at which there will be a number of short speeches, followed by other entertainment. As in the past few years, the annual meeting will be paralleled by the National Exposition of Power and Mechanical Engineering to be held in the Grand Central Palace, New York. Over five hundred exhibits of all types of power and mechanical apparatus will fill four floors of the Palace during the entire week.

A SPECIAL evening session planned to appeal to the general public is to be held during the International Conference on Bituminous Coal, which takes place at the Carnegie Institute of Technology from November 15 to 18. John Hays Hammond, inventor and engineer, will preside at this session on November 15 and the principal addresses will be given by Walter Barnum, president of the National Coal Association, and Edwin E. Slosson, director of Science Service. Mr. Hammond and Mr. Barnum are members of the advisory board assisting President Thomas S. Baker in planning the Carnegie Conference.

THERE has been recently formed a China branch of the American Society of Parasitologists. The members of the branch society are active members of the parent society but have their own chairman, secretary and organization. The China branch which now has a membership of about forty plans to have meetings at frequent intervals. Its object is the encouragement of teaching and research in parasitology in China. Dr. E. C. Faust, professor of parasitology in the Peking Union Medical College, was elected the first chairman. This position makes him also a vice-president in the American Society of Parasitologists. The secretary-treasurer of the China branch is Dr. Chenfu T. Wu, of Yenching University.

A MEETING of the International Society for the Exploration of the Arctic Region by means of the airship will be held at Berlin, from November 10 to 12, under the chairmanship of Dr. Fridjof Nansen. The subjects to be discussed are chiefly organization and statutes, investigational work in oceanography, meteorology, geology, biology, terrestrial magnetism and electricity. Professor L. A. Bauer, of the Carnegie Institution in Washington, will represent America. Sir Napier Shaw, meteorologist, will appear for England, and Captain Walter Bruns, Zeppelin pilot, represents Germany. Roald Amundsen and General Umberto Nobile, who flew over the North Pole in the airship *Norge,* expressed regrets at their being unable to attend.

THE École d'Anthropologie de Paris celebrated the fiftieth anniversary of its foundation on November 3.

THE Royal Belgian Geographical Society will celebrate the fiftieth anniversary of its foundation on November 7 and the following few days.

A COLLECTION of more than 1,000 books which constituted the library of the late Dr. David C. English, of New Brunswick, has been given to the Rutgers University library. Two thirds of the collection are medical books, including several rare texts dating back to the seventeenth century.

UNIVERSITY AND EDUCATIONAL NOTES

LORD WOOLAVINGTON has given £10,000 to Edinburgh University for the endowment of the animal breeding research department. This gift follows an offer by the Rockefeller International Education Board of £30,000 for a department, on condition that a similar sum was raised in England.

THE University of Aberdeen has announced a gift of £5,000 from Lord Cowdray to be applied towards the endowment of a chair of forestry.

DR. SUMNER C. BROOKS, of the hygienic laboratory of the U. S. Public Health Service, has been appointed professor of physiology at Rutgers University.

H. L. CLAPP, of Cincinnati, has been appointed professor of chemistry in the college of the City of New York.

DONALD B. MACMILLAN, Arctic explorer, who plans an expedition to the Far North, which will start in the spring of 1927 and remain for five years, has been appointed professor of ethnography with leave of absence in the field, at Bowdoin College.

IN the department of psychology at the University of Kentucky Dr. Gardner C. Basset, formerly of the University of Pittsburgh, has been appointed associate professor, and Dr. James L. Graham, who car-

ried out his graduate studies at Columbia University, assistant professor.

DR. AXEL M. HJORT has been appointed a professor of pharmacology in the Dartmouth Medical School. Dr. Hjort, a graduate of the University of Illinois, received his M.D. and Ph.D. degrees from Yale University, where he taught pharmacology for five years; more recently he has been engaged in research for Parke, Davis and Company.

DR. GEORGE B. RAY and Dr. David Rapport have been promoted to be assistant professors of physiology at Western Reserve University.

PROFESSOR JOHN A. FERGUSON, head of the department of forestry at Pennsylvania State College, has been appointed visiting professor of forestry at Yale for the year 1926–27. Professor Ferguson will take over the work in forest management while Professor Herman H. Chapman is on leave of absence to participate in the government investigation in forest taxation.

LOUIS O. HOWARD has resigned as dean of the school of mines and geology of the State College of Washington. He will give, this winter, courses in metallurgy at the South Dakota School of Mines at Rapid City, taking the place of Bancroft Gore, who has gone to South America.

DR. HARRY S. LADD has returned from an extended field season in the Fiji Islands to become assistant professor of geology at the University of Virginia.

DISCUSSION AND CORRESPONDENCE

HOOKE'S LAW: A REJOINDER

PROFESSOR JOSEPH O. THOMPSON'S discussion on Hooke's law[1] reflects a view of physical laboratory instruction which, to say the least, is unusual. It appears that many years ago he performed experiments on very thin wires of brass and copper having a length of nearly twenty-three meters; in loading these wires he found what appear to be systematic departures from Hooke's law. In view of the importance of the elastic properties of steel, his data on steel would have been interesting also, as would have been the figures for brass and copper with diminishing load. It happens that the elastic properties of brass and copper are of small practical consequence. It also happens that in a wire as fine as those he used the questions of uniformity of cross-section and of homogeneous structure become very important. Having found the anomalies in wires which are not representative either in dimensions or materials of wires whose elastic properties find practical application, it is his opinion that these anomalies should be emphasized and that unless they are emphasized the instruction is harmful. This is a view which very few teachers of physics will share.

I must correct one statement in particular which Professor Thompson has made. He says that "a certain well-known scientific company is doing harm to young experimenters all over the country by publishing an elaborate instruction sheet which conveys the impression that accurate measurements should show strict proportionality between strain and stress." The reference is probably to Experiment M-27A of the "Cumulative Unit System of Laboratory Experiments in Physics," for the preparation of which the writer is responsible. This series of experiments is intended to teach that careful experimental work with suitable apparatus leads to results which demonstrate, *within the limits of experimental error,* the correctness of the laws governing certain physical relationships. The experiment in question deals with Hooke's law only incidentally, its Fig. 5 being a graph showing the experimentally determined relation between stress and strain. This graph, which is a straight line, shows that the elongation is, *within the limits of experimental error,* proportional to the stretching force. Beyond this it does not convey the impression "that accurate measurements should show strict proportionality between stress and strain." This has been read into the presentation by Professor Thompson.

It should be particularly noted that the experiments for which data are shown were performed with wire of piano steel, having diameters of approximately 0.6 and 0.7 mm, respectively, and a length of about one meter. If in steel wires of such dimensions there is in fact such lack of proportionality as Professor Thompson believes to exist, the apparatus used, although capable of accurate measurement, would fall far short of sufficient precision to show the lack of proportionality. Unless the student were to reproduce Professor Thompson's research experiments he could come to but one conclusion, namely, that *Hooke's law is a correct statement of what he has observed.*

The objection made by Professor Thompson, if valid, must for the sake of consistency apply also to the measurement of acceleration of gravity by means of the simple pendulum. Unless the angle of swing is nearly zero the time of vibration is not expressed by the simple harmonic formula; but the student must in his computations assume the formula to represent the facts. To be consistent, objection must also be made to the experimental method of studying the laws of Boyle and Charles because, unless van der

[1] SCIENCE, September 24, 1926, page 298.

Waal's equation is used, the truth is only approximated. In these various experiments we shall (granting the validity of the objection) be "doing harm to young experimenters" unless we stress the slight systematic departures from the laws which are being studied.

As Professor Thompson points out, the instruction sheet which is doing the harm is in good company. It can even boast of companionship with classic works such as Poynting and Thomson's "Properties of Matter" and with the "Dictionary of Applied Physics." The question can therefore in all fairness be asked whether we should not be doing greater harm by diverting the student's attention from the fundamentally important law than we are doing in ignoring departures from the law which have no practical significance.

PAUL E. KLOPSTEG
DEVELOPMENT LABORATORY,
CENTRAL SCIENTIFIC COMPANY

A HERMAPHRODITIC VIVIPAROUS OYSTER OF THE ATLANTIC COAST OF NORTH AMERICA

WHILE engaged in scallop studies at the U. S. Bureau of Fisheries Laboratory, Beaufort, N. C., in 1925, my attention was drawn to a small oyster which became so numerous on the scallops of one particular shoal as to be a scallop pest, if not a scallop enemy. Its general external appearance was not sufficiently different from that of the common oyster of commerce [*Ostrea virginica* Gmelin (= *elongata* Solander)] to suggest specific distinctions and it was at first assumed to be that form. Therefore, my surprise may be imagined when on October 6 I saw an individual throwing out large numbers of minute, active specks which were shell-bearing bivalves suggestive of oyster larvæ. Soon others were found to be doing the same. Numerous individuals were then secured and placed in separate dishes for observation. In the course of a few days nearly all these threw out shelled larvæ, some of which were kept alive for many days and made moderate growth for a time. The larvæ bore considerable resemblance to those of the oviparous *Ostrea virginica* but were larger for a corresponding stage of development, as judged by shell shape.

That these small oysters were not *Ostrea virginica*, having been thus demonstrated, an effort was made to identify them. The range limits as given by Dall (U. S. National Museum, Bulletin 37) eliminated all but the common oyster and *Ostrea equestris* Say and thus indicated the latter species to be the one under observation.

The specimens were found to correspond well with Say's description and in one important respect with his figure. Later specimens were identified by W. H. Dall as *Ostrea equestris* Say.

Specimens, generally fixed in picro-aceto-formal, were secured at intervals through the fall, winter and spring and were imbedded, sectioned, stained and studied. The study is being continued.

In the meantime a few words as to conditions found and indications arising therefrom may not be out of place. Notes from examinations of sectioned specimens are as follows: October 6, embryos in the mantle cavity, in the gonad a few mature or nearly mature eggs and vast numbers of sperms; January 12, well-developed "ovarian" eggs and a few sperms; February 12, a narrow zone of germ cells, the sex of which has not been made out; February 16, sperms fully developed (spermatozoa) and very abundant small eggs fairly numerous; April 2 (two specimens), eggs immature and not very numerous; April 13, small eggs and larger eggs fairly numerous; April 29 (two specimens), large eggs fairly numerous, small ones not numerous, vacated areas present, sperms in various stages fairly numerous. On June 5 a specimen was found with objects in the mantle cavity which appeared to be eggs surrounded by sperms. On June 9 two apparently uninjured oysters cast out great numbers of larvæ, apparently till empty of them. One of these and the individual examined June 5 have been preserved for future study. The other is being kept in the hope that its condition may be determined at a later date.

I take these data to indicate an alternating hermaphroditism with overlapping similar to that described for the European *Ostrea edulis*, another viviparous oyster. Because summer specimens have not been examined, it is impossible to say whether spawning, for the species or "colony," is long drawn out or occurs at clearly separated intervals but more than once a year. A multiple cycle of eggs and sperm production per year per individual does not seem out of the question.

J. S. GUTSELL
BUREAU OF FISHERIES,
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SCABLAND MOUNDS OF EASTERN WASHINGTON

ON the channeled scablands of eastern Washington are found thousands of nearly circular mounds composed of different material than would be formed from the weathering of the basalt that is the chief bedrock of this region. The mounds only occur on top of the bare basaltic rock of the Columbia Plateau. They never occur on granite, schists or quartzite that occasionally outcrops. Neither do they occur on the

loessial hills of Palouse soil or in peat swamps scattered through the scablands.

The mounds average practically circular. Careful measurements failed to show any greater elongation in one direction than another. The highest point of the mounds is the center. They thus differ in shape from ordinary sand dunes. The mounds are of all sizes, from a few feet across to over one hundred feet and average around thirty to forty feet in diameter. They rarely exceed three or four feet in height above the scabrock. The material composing them is loess like and differs so markedly from soil formed from basalt that little of it can be derived from that source. It appears to have been brought in from elsewhere and deposited by the wind. The source of the material was probably the soft lake beds of the Ellensburg formation of south central Washington and the finest outwash material of the glacial period. Where I have studied the mounds in the northern half of the scabland area they practically without exception occur above a depression in the basalt. The depression is sometimes shallow, making the cross-section of a mound lens-like; in other cases it has steep sides like a pothole. In either case the basalt under the mound is very little weathered and makes a sharp contact with the mound. Such weathering as occurred resulted in chipping off small fragments of the basalt from the sides of the depression which are scattered through some of the mounds, chiefly in their lower part.

The work of Bretz (*Jour. of Geol.*, Vol. 23, pp. 139 to 149, Vol. 31, pp. 617 to 649) on the channeled scablands shows that the Spokane flood from a rapidly melting ice sheet removed the surface soil from the basalt and by the suction of the swirling torrent plucked out from the stream beds great chunks of the jointed lava, leaving its surface in a highly pitted condition. We only find the mounds in places where the basalt's surface contains depressions. The mounds are found in the midst of level areas, on the sides of hills, at the edge of rock terraces and even on top of small isolated hills of basalt. They occur both in the timbered and treeless parts of the scablands. In fact, they may occur anywhere on the bare basaltic rock and never elsewhere in this region. Their absence from the surface of crystalline rock is accounted for by the fact that such rock is denser and that potholes or other depressions were not worn into its surface. A considerable number of mounds have been cut through in road and railroad cuts, and a few wells and vegetable pits have been dug in them. Besides examining such, I have trenched several others. In the areas so far examined I have invariably found that the mounds occur over a depression in the scabrock. In the bottom of the depression there may be gravel and a few boulders washed in by the Spokane flood and some chips of basalt from the weathering of the sides; aside from this the depression is filled with the loess that composes the mound that rises above it. Some of the depressions are shallow with gentle slopes, others are many feet deep with steep sides. A well in one case was dug twelve feet deep in a mound below the level of the scabrock without striking bottom.

Apparently at the close of the Spokane flood the basaltic lava was left with a decidedly pitted surface, the depressions of which had about the same dimensions in various directions. Sediment accumulated first in such depressions. Vegetation started growing on the sediment and retained the wind-blown material until the entire depression was surrounded and surmounted by a mound. The fine material of the mounds holds moisture better than the scabrock and the depression beneath is a storehouse of moisture which helps to promote a vigorous plant growth. It seems probable that the mounds were chiefly formed soon after the glacial period, although the much more luxuriant growth of grass on them to-day than on the bare basalt would permit additional wind-blown material to be caught and retained. Mounds have been reported outside the channeled scablands on the basalt of the Columbia Plateau but have not been examined by the writer. It would be of interest to learn if these mounds occur above natural depressions in the lava. It also may be that some lens-shaped mounds reported from other sections of the United States may be found to have grown as the result of more luxuriant vegetation in them, catching and holding wind-blown material until the mounds were formed.

The mounds are of economic importance to the inhabitants of the scablands. They provide the best available grazing aside from certain peat swamps. Corn, melons, sweet clover, potatoes and garden truck flourish when planted on the mounds, as the plants draw on the moisture in the soil that fills the depressions. It is difficult, however, to cultivate most of the mounds, due to their small size.

O. W. FREEMAN

STATE NORMAL SCHOOL,
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FURTHER ON AERIAL SOUNDS IN YELLOWSTONE PARK

SINCE the publication of my note in your issue of July 30, my attention has been called to a much fuller and more important article on the phenomenon I described, written by Dr. Edwin Linton and published in SCIENCE (old series) for November 3, 1893. I suppose that I must have seen this article at the time,

but, if so, I had completely forgotten it. Any one interested in our subject should not fail to look it up, as it is by far the most careful and detailed description of the mysterious aerial sounds of Yellowstone Park which has thus far been given by any one.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A RAPID IRON HAEMATOXYLIN TECHNIQUE

THERE seems to have been little if any work done aiming to secure a stock solution of haematoxylin which would remain indefinitely, or at least for a long time, in an entirely unoxidized condition. Such a solution would appear to be useful, especially in view of the fact that unoxidized haematoxylin solutions can be oxidized almost instantaneously by the addition of appropriate substances.[1,2,3] This line of procedure seemed to the writer to offer promising possibilities. If one could start with a totally unoxidized solution it would seem possible to devise a technique that would permit the stain to reach the tissue sections at the peak of the staining power, thus making possible a maximum of action in a minimum of time. The duration of the staining power of the solution would be of minor importance, providing that the method of preparing the ready stain were simple and rapid.

A series of experiments with the above considerations in mind has resulted in a technique which has been used with success on a considerable variety of tissues, following fixation in corrosive acetic, Bouin's, Carnoy's No. 1 or Zenker's solution. The formulae for the necessary stock solutions are as follows:

Mordant	50 per cent. alcohol	20 cc
	Ferric chloride	1 grm
	Glacial acetic	2 cc
Stock Haematoxylin Solution	Absolute alcohol	20 cc
	Sodium hydrosulphite	0.2 grm
	Distilled water	5 drops
	Haematoxylin crystals	1 grm

In the stock haematoxylin solution only a slight amount of the sodium hydrosulphite ($Na_2S_2O_4$) will dissolve.[4] It is necessary that an excess be added, so that at all times there will be some crystals in the bottle. The haematoxylin crystals should be the light brown, not the dark product.[5] After the ingredients have been mixed the bottle should be stoppered and solution facilitated by shaking. This completes the preparation of a very powerful stock solution which will keep without oxidation for a long time. Such a solution, which has been kept in ordinary daylight for over a year, still retains its original light amber color and shows no sign of oxidation. Tests made at intervals show that its staining power is unimpaired.

The mordant and stain may be used separately or combined. Staining may be accomplished either by flooding the slides or by immersion in staining jars. This procedure is not only useful for sections but also has a somewhat more restricted use for staining in bulk. The capabilities and limitations of this technique are being investigated further. At present it may be said that flooding sectioned material affixed to slides, first with the mordant and then with the stain, gives the best results. It has been found most convenient to keep both mordant and ready stain in dropping bottles.

Before giving the general outline of procedure it is necessary to describe the method of preparing the ready stain. To five cc of tap water in a dropping bottle are added five drops of the stock haematoxylin solution, followed by one drop of ammonium hydroxide. The solution is ready for use within thirty seconds and will retain vigorous staining power for about four hours. The substitution of 95 per cent. alcohol for water in the preparation of the ready stain increases the life of the solution so that it will stain satisfactorily for five days or even longer. The alcoholic solution, however, will not stain vigorously until it has set about twenty minutes after preparation. If the five drops of stock solution are added to ten drops of tap water, and a drop of ammonium hydroxide then added, oxidation proceeds rapidly. After thirty seconds five cc of 95 per cent. alcohol may be added. The stain is then ready for immediate use and has a considerably longer life than the aqueous ready stain. This last modification, then, combines the immediate readiness of the first solution and the longer life of the second.

Sections, in paraffin ribbons, are affixed to slides by the albumen and water method and are allowed to dry into contact. Then follows the usual proce-

[1] Mayer, Paul, 1891, "Ueber das Färben mit Hämatoxylin," Mitth. Zool. Stat. Neapel, Bd. 10, Heft 1, S. 170–186.

[2] Unna, P. G., 1892, "Ueber die Reifung unsere Farbstoffe," *Zeit. wiss. Mikr.*, Bd. 8, S. 475–487.

[3] Piazza, C., 1912, "L'invecchiamento rapido delle soluzioni ematossiliniche," *Zeit. wiss. Mikr.*, Bd. 29, S. 69–71.

[4] Sodium hydrosulphite used was that manufactured by E. I. du Pont de Nemours and Co., Inc.

[5] Light brown haematoxylin crystals manufactured by McAndrews and Forbes were used and gave entire satisfaction.

dure, involving the removal of paraffin and the running of the slides down the graded alcohols to water. A slide is then flooded with a few drops of mordant, used full strength. After five minutes the slide is rinsed for a few seconds in tap water and flooded with ready stain. Staining begins at once and is complete in ten minutes or less. After rinsing the slide is differentiated in 0.1 to 0.4 per cent. hydrochloric acid in water. When differentiation has reached the desired point the slide is transferred without rinsing to a jar of water containing one or two drops of ammonium hydroxide. As soon as the blue color has appeared in the sections the slide is removed, counterstained with erythrosin, passed up the graded alcohols to xylol and mounted in balsam. The final mount shows nuclear material in deep blue and cytoplasmic material in pink. The results are comparable to those obtained with the use of Delafield's haematoxylin, followed by erythrosin.

The color of the ready stain gives a clue as to the color of the nuclear material in the final preparation. Freshly prepared aqueous ready stain is deep purple in color, with a strong tint of blue. It will stain nuclear material a deep blue. After about an hour the ready stain has lost most of its blue tint and is a red orange in color. It will then stain nuclear material a bluish black. Still older stain will give a black nuclear stain. In other words, as oxidation of the ready stain proceeds the color changes from brilliant blue-purple to purple to orange-red to orange brown, and the color of the nuclear stain secured progresses from brilliant blue to blue-black to black. When the stain has reached the orange brown stage its staining power is largely gone and its use will give an undesirable yellow-brown nuclear staining but little stronger than the color imparted to the cytoplasm. The black nuclear stain resulting from the use of the orange-red ready stain is comparable to that secured by the use of Heidenhain's iron haematoxylin.

The ammonium hydroxide used as a "bluing" agent has the most powerful action on the color of sections stained with fresh stain, and least with those stained with the old stain. While there is a considerable amount of haematoxylin dissolved in the ammonia of the ready stain the nuclear stain resulting will be distinctly blue; as more and more of the haematoxylin becomes converted into haemateïn-ammonia and further oxidation products the resulting nuclear stain tends more and more toward black.

The best way to secure a blue nuclear stain is to use a freshly prepared ready stain. If an aqueous one, it should be used for this purpose within a half hour; if an alcoholic solution, within eight or ten hours. There are several ways in which to secure a black nuclear stain. First, use old ready stains; second, add two or three drops of ammonia in the preparation of the ready stain; third, flood slides with either fresh or old ready stain, and add a drop of dilute ammonium hydroxide to each slide. In any case the desired results will have been secured when the stain flooded on the slide has become orange brown in color. Contrary to expectations, the use of ammonium hydroxide as described in these three variations does not appear to injure the tissues. The third method is, perhaps, the easiest and best. As soon as the flooded stain has become orange brown in color the slide may be rinsed in tap water, counterstained, dehydrated, cleared and mounted in balsam. It must be admitted that there is still some question as to the permanence of the stain, but a number of slides stained by the methods given above show no signs of fading, although exposed for several months to ordinary daylight. Further study is being made along these lines and results will be reported at the appropriate time.

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SPECIAL ARTICLES

THE EFFECT OF PRESSURE ON THE MAGNETIZATION OF MAGNETITE

AMONG the interesting properties of magnetite, $FeO.Fe_2O_3$, is that of being oxidizable to Fe_2O_3 without loss of its ferro-magnetism and without a change in its cubic crystal structure. A closer study of this phenomenon and of hysteresis in magnetite reveals the following three facts which clearly suggest that hydrostatic pressure should increase the permeability:

(1) Magnetite oxidized to Fe_2O_3 is even more magnetic than before oxidation.[1] In one sample the maximum permeability increased 16 per cent. and the position of the maximum was shifted from a magnetizing field of 85 to 65 gausses.

(2) On annealing magnetite at 1000° C. the permeability maximum is shifted from 85 gausses to about 350.[2] Since annealing implies the removal of strains, the shift from 85 gausses to 65 produced by oxidation means that any existing strains were then increased.

(3) A consideration of the inter-atomic distances in magnetite[3] shows that the free unoccupied radial distance is 0.55Å, whereas the oxygen radius is usually found to be 0.65Å. The oxygen which enters on oxida-

[1] *Phil. Mag.*, 1925, 1, 403.
[2] *Phil. Mag.*, in press.
[3] *Phil. Mag.*, 1925, 1, 406.

tion, therefore, fits in rather tightly and acts in such a way as to compress the structure.

Through the courtesy of the physics department of Cornell University I was enabled, during a brief stay there the past summer, to study the effect of pressure on magnetization. The magnetite tested was of the variety lodestone from Alameda County, California, and was used in the form of a cylinder 3.3 cm long and of 1.1 cm diameter cut approximately parallel to the original direction of magnetization. It was demagnetized in a gradually decreasing alternating field. It appears from the magnetometer readings that the specimen was still "biased," since they are not symmetrical about the zero.

The pressure chamber was a cylinder of manganese bronze. The lower part of an axial hole was just large enough to accommodate the specimen contained in a thin brass cup to facilitate handling. The upper part of the hole was of 1.9 cm (three quarter inch) diameter. Into this was fitted a manganese bronze plunger, the clearance allowed being one one thousandth inch. The compression fluid used was a motor oil of the grade "extra heavy." A hydraulic press forced the plunger into the oil. Owing to the high viscosity the leak of oil past the plunger was slow and it was not difficult to reach the desired pressure. The chamber was wound with a magnetizing coil along practically its entire length. The field as calculated by the solenoid formula requires correction for the increase due to the iron of the press. It was found to be 6.1 per cent. and is included in the fields recorded.

The data obtained pertain only to the permanent magnetism. The procedure adopted when the effect of pressure was sought was to leave the magnetizing field on while the pressure was brought to the desired value and then back to atmospheric pressure. A United States engineers' compass was used as a magnetometer. The deflections were small enough so that the moments are considered to be proportional to the angles themselves.

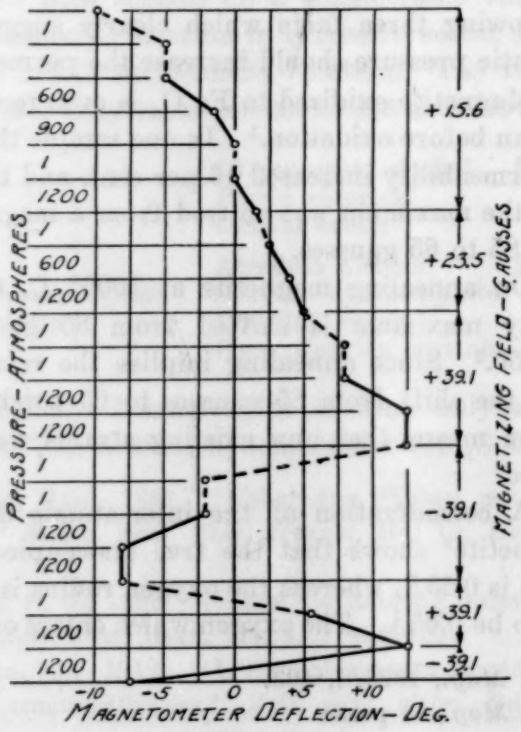

FIG. 1

A typical set of observations is shown in Fig. 1. Reading downward, each step represents an operation, with the field shown on the right at the pressure indicated on the left. Operations carried out at atmospheric pressure are indicated by broken lines. The deflections are magnetometer readings after the indicated operation. The qualitative nature of the effect is brought out in the upper part of the figure. The three complete reversals shown in the lower part give us a quantitative measure at that particular magnetizing field and pressure. It is, evidently, either of the ratios

$$\frac{\Delta\theta_{p=1200}}{\Delta\theta_{p=1}} \text{ or } \frac{\Delta\theta_{p=1}+\Delta\theta_{p=1200}}{\Delta\theta_{p=1}}$$

since we may perform the reversal directly at the higher pressure or we may perform part of it at atmospheric pressure and then the remainder at the high pressure. The three reversals shown in the figure give for the ratio the average value 1.45. A similar and more extended series of observations contains four complete reversals and yields as an average

$$\frac{\Delta\theta_{p=1200}}{\Delta\theta_{p=1}} = 1.51.$$

We may, then, state the results in the form: At a pressure of 1,200 atmospheres and with a magnetizing field of 39.1 gausses the change of magnetic moment in magnetite is from 45 to 51 per cent. greater than the corresponding change at atmospheric pressure.

Pressures exceeding 1,200 atmospheres could not be reached with the bronze plunger on account of the danger that it would swell permanently and stick in the hole. A steel plunger was then made and a pressure of 1,900 atmospheres was reached. At that pressure the chamber stretched and began to leak around the plunger. The steel plunger increased the magnetizing field by an unknown amount and the results are not free from the additional objection that the steel's disturbing influence on the field might depend on the pressure.

A series of observations made while using the steel plunger contains three reversals and the average ratio at 1,900 atmospheres was

$$\frac{\Delta\theta_{p=1900}}{\Delta\theta_{p=1}} = 2.3.$$

It should be pointed out that these ratios are in the nature of minimum values and that the true effect of pressure on the permanent magnetization is really greater. The reason is that the specimen was short, with a large demagnetizing factor which interfered with the full development of the pressure effect. It should also be stated that the effect of pressure on the temporary magnetization should be relatively greater since it is known from our work on artificial magnetite[4] that strains of the compression type decrease the remanence.

The bearing of the present results on the general problem of ferro-magnetism is not clear. It is in their relations to other questions that they are of interest. First is the question of the origin of lodestone. It is manifestly impossible to imagine any magnetizing field of natural origin sufficiently large to give to lodestone its marked magnetic moment.[5] Unless one assumes some entirely unfamiliar process of magnetization one is forced to admit that the magnetic characteristics of magnetite are enormously magnified under pressure and, perhaps, temperature conditions such as found at great depths. The results herein described scarcely do more than show that the pressure effect is of the required sign. They represent a mere beginning in the attainment of the desired result, as is shown by the fact that the original natural moment of the specimen employed was 130 times the moment observed after magnetizing with a field of 39.1 gausses at 1,200 atmospheres pressure.

The other question is that of the contribution of the earth's material to its magnetic field. Much of the earth's crust is iron oxide. More specifically,[6] six per cent. of the outer ten miles is made up of the oxides of iron in their various forms. It is evident, if this material plays any part whatever in the earth's magnetic phenomena, that the contribution is larger than one would suppose from a study of magnetite under ordinary conditions. In any event, local magnetic anomalies which are known to be due to deposits of iron ore appear in an exaggerated form.

Several lines of research suggest themselves here. It would be interesting to see if the pressure effect is itself a function of the temperature. It would be of particular importance to learn if the critical temperature of magnetization is increased by pressure, not only in magnetite but in iron and nickel as well. It is strange, indeed, often as the suggestion has been made in the literature of the earth's magnetism, that no experiments in this direction have yet been made. Perhaps the difficulty of the large demagnetizing factor for a spherical body like the earth is considered to be so decisive and so insurmountable that a study of earth materials, under pressures and temperatures approaching as far as possible those existing in the earth, would be of no value to our knowledge of terrestrial magnetism.

Finally, it may be suggested that the property of magnetite herein described might be used, in principle at least, as a high pressure gauge.

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September 27, 1926

[4] *Phil. Mag.*, in press.

[5] Since writing this article it has occurred to me that such a field would exist in the neighborhood of a lightning flash. On looking through the literature I find that Pockels made use of this fact to measure the maximum current during the discharge. See *Phys. Zeit.*, 1901, II, 306 and III, 22.

[6] Proc. Nat. Acad. Sci., 1920, vi, 592.

PRELIMINARY NOTE ON THE EGG AND LARVA OF THE AMERICAN EEL (ANGUILLA ROSTRATA)

FOUR eggs provisionally identified as those of the American eel, *Anguilla rostrata,* were taken while on the *Arcturus* Oceanographical Expedition on July 16, 1925. The catch was made on the edge of the Challenger Bank, a shoal about ten miles southwest of Bermuda (Lat. 32°02′N, Long. 65°00′W), in a Petersen trawl towed at five hundred fathoms below the surface. The depth increases very rapidly from the banks, a sounding made just before the trawl giving 505.7 fathoms, and one not long after 2,116 fathoms.

The eggs closely resembled those of the few species of eels and eel-like fishes which are known. They were highly transparent, colorless except for a slight yellowish tinge of the yolk, and measured 3.3 mm in outside diameter. No oil globules were present. They were further characterized by a very wide perivitelline space, the diameter of the yolk measuring 1.7 mm. A very early stage of development had been reached, for the germinal disc was defined without evidence of cleavage. As development progressed the posterior extension of the vesicular yolk into a narrow stalk below the intestine nearly to the region of the vent was typical of a murænoid embryo.

After an incubation of approximately seven days a ribbon-shaped, transparent prelarva emerged. It was 9 mm long, colorless except for ocular pigment, and provided with three pairs of very large teeth in the upper jaw, and four pairs in the lower. The anterior upper teeth were enormous fangs. When the eel was living there appeared to be a very few black chromatophores on the caudal portion of the

embryonic fin, but as this region was somewhat mutilated after death, their presence has not definitely been established. The embryonic fin enveloped the body without indication of finrays. Pectorals were prominent. No hypural elements had developed, the end of the notachord being quite straight. At twenty-four hours the prelarva had increased to 10 mm in length and four pairs of teeth could be seen in each jaw, longer and much slenderer than on the previous day.

Were it possible to obtain descriptions of the young of all living eels, one might with certainty attribute this leptocephalus to a particular species. Every expedition at sea, however, captures more new species, so that, although I feel reasonably sure that the proof in this case is quite conclusive, it is only provisionally that the eggs and young at hand are called *Anguilla rostrata*. The evidence for this identification may be summed up as follows:

(1) *Character of the eggs:* The eggs were definitely those of an eel or eel-like fish, evidenced by their large size, large perivitelline space, vesicular-stalked yolk, and slightly iridescent cell membrane, fine in texture and lacking pore canals, as well as by the leptocephalid character of the larvae hatching from them. They were different from any murænoid eggs previously observed.

(2) *Location of the collecting-ground:* The eggs were found within the area designated by Schmidt to encompass the breeding ground of the American and European eels. In the absence of closing net hauls it is impossible to state at what level they were taken. The nets rose to the surface open and consequently fished at various depths. At the time of the collection four surface nets, meter nets at three hundred and four hundred fathoms, and a meter net and Petersen trawl at five hundred fathoms were towing. The fact that but four eggs were taken in the trawl and none in the meter net at the same depth would indicate that the eggs were not abundant. If we were able to conclude, from the fact that the eggs were collected only by the deepest net, that they were taken while towing at five hundred fathoms and not during its passage from this depth to the surface, then the early stage of development attained would favor a previous theory of fertilization at considerable depths.

(3) *Comparison of this prelarva with an European eel 6 mm long:* Since the two species *Anguilla rostrata* and *Anguilla vulgaris* are so closely allied that distinction is based mostly upon the difference of only a few muscle segments, it is logical to suppose that the earliest larval stages will show like similarity. The present prelarva strikingly resembles the European eel prelarva in the general proportions of the body, the teeth and the probable presence of pigment on the caudal portion of the embryonic fin, but the pigmented eye and the absence of an oil globule, as well as the difference in myomere count, show them to be separate species.

(4) *Comparison of this prelarva with an American eel 10½ mm long:* The smallest American eel prelarva previously recorded was pictured by Schmidt (1916). It measured 10½ mm after preservation and was obviously in a later stage of development than my specimen. The dental formula $\frac{1+3}{1+3}$ was identical in the two prelarvae, but the teeth of Schmidt's specimen were more even, stronger and less tapering, like those of older leptocephali. The depth of the body of the latter was slightly greater, a change which is known to occur as development progresses. Pigmentation, as in the present specimen, was restricted to the eye and a few black stellate chromatophores on the embryonic fin near the tip of the tail (not on the tail itself). The number of myomeres was the same.

(5) *Myomere count:* A character which remains constant throughout all stages of development is the number of muscle segments and vertebrae. According to the principle adopted by most investigators interested in the eel question, "A species is regarded as new only when it differs from all known species in which the myomere count is known" (Lea). This leptocephalus has the same number of muscle segments as the American eel, and no other larva or adult species of an eel has this count. Of those species which have a number of muscle segments within twenty of the present specimen, there are other specific differences which allow their elimination.

Since the time of the early Greeks scientists have speculated upon the mysterious reproductive methods of the eel, and it was not until after 1904, when Johannes Schmidt began his intensive work upon this subject, that its breeding ground was definitely located. If my identification is indeed correct, the sea has given up the last secret concerning the life history of the American eel which it has jealously guarded for so many centuries.

A complete account and a number of illustrations of these eggs and the larva, together with a review of previous literature on the embryology of other eels and the life history of the common eel, has been submitted to the U. S. Bureau of Fisheries, and will be published by the New York Zoological Society in a forthcoming volume of *Zoologica*.

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ACIDOSIS, TREMBLES AND MILKSICKNESS

DURING a biochemical study of the course of sickness in animals poisoned by richweed (*Eupatorium*

urticaefolium, Reichard) or by the rayless goldenrod (*Aplopappus heterophyllus,* (A. Gray) Blake, formerly known as *Isocoma wrightii,* Rydb.), it was observed that excretion of acetone by the lungs and kidneys is a constant symptom of poisoning. Some twenty-four hours after the first symptoms of trembling appear, sick animals begin to excrete large quantities of acetone. The urine becomes strongly acid and reeks of this ketone. It seldom contains albumen, and sugar was observed in two cases only. β-oxybutyric acid and acetoacetic acid have not been found in the urines examined.

EXPERIMENTAL RESULTS

Fifteen cases were studied. Of these, five were sheep poisoned by richweed, seven were sheep poisoned by rayless goldenrod, and three were cattle, one cow and two calves, also poisoned by rayless goldenrod.

All the richweed cases excreted acetone by lungs and kidneys. A quantitative determination of the urinary acetone in one case showed the presence of 24.32 mg of acetone per 100 cc. In two cases samples of blood were also obtained, and these were positive to tests for acetone.

Of the animals poisoned by the rayless goldenrod, acetone was demonstrated in the urine of six sheep that also carried the odor of this ketone on the expired air. In one case a quantitative determination of urinary acetone showed the presence of 34.35 mg per 100 cc. The seventh case showed no symptoms of trembles and probably was not poisoned. At no time did this sheep excrete acetone nor was the urine ever acid. The urine of the three cattle was collected at autopsy and in one case we were fortunate enough to obtain a good sample of blood. All the samples contained acetone.

Blood sugar determinations were made in several cases and showed a large increase in the concentration of glucose. One animal poisoned by rayless goldenrod had a blood sugar concentration of 0.1472 gram per 100 cc; another, poisoned by richweed, had 0.1680 gram per 100 cc. The normal figures for these animals were 0.090 to 0.100 gram per 100 cc.

SUMMARY OF FINDINGS

The findings indicate that animals poisoned by these two plants suffer from an acidosis. The fact that excretion of acetone does not begin until after the onset of the characteristic trembling—whence the common name "trembles" for the disease—suggests that the ketogenesis may be a secondary effect of the intoxication. This is supported by the fact that common remedies for acidosis do not appear to alter the course of the disease.

It is probable that the toxic principles of these two plants are excreted in the milk of lactating animals. The suckling young of animals feeding on these plants may be poisoned and exhibit the characteristic symptoms, such as trembles and acidosis. Consequently, human beings who drink milk or eat butter obtained from cows that have grazed on either of these plants are in danger of being poisoned. Cases of this sort are not rare in districts where the plants are abundant. "Milksickness," as the human disease is termed, occurs especially in the late summer and autumn at a time when trembles in cattle and sheep is also prevalent. In human cases the odor of acetone has been constantly remarked and is considered a diagnostic symptom. Dr. W. E. Walsh, of Morris, Illinois,[1] diagnosed the human disease as an acidosis and recommended the use of sodium bicarbonate as a remedy. The present study supplements this diagnosis with a demonstration that acidosis is present in the cattle disease also.

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THE WORLD'S FORESTRY CONGRESS

OTHER international forestry congresses have been held, but that of 1926 was attended by more delegates from more different nations than any other. Fifty-eight different countries were represented at the World's Forestry Congress held at Rome, Italy, from April 29 to May 5, 1926, with some six hundred to eight hundred delegates attending. The leading foresters of Europe were there, with many other well-known experts, economists and scientists—also a few politicians. Naturally, Italy led in number of delegates, most of whom were certified as official. His Majesty, the King of Italy, and Signor Benito Mussolini were present at the opening session at the Teatro Quirinale.

The congress was held under the auspices of the International Institute of Agriculture, in the very beautiful building in the spacious park known as Villa Umberto. The origins of this congress date back to 1922 and to the sixth annual general assembly of the International Institute held that year in Rome. At that meeting it was decided to invite all nations to a conference in Rome in 1926 to consider world problems of forestry, with especial reference to supply and consumption. Prior forestry congresses have been held in Paris in 1900 and in 1913 and others of more limited scope in recent years.

[1] *Illinois Med. J.,* n. s., 15, 422–5, 1909.